


**CGSIC - 44th Meeting**  
**U.S. States and Localities Session**  
**Washington State**



A historical map of Washington Territory, titled 'MAP OF PUBLIC SURVEYS IN THE TERRITORY OF WASHINGTON. TO ACCOMPANY REPORT OF SURVEYOR GENERAL. 1865.' The map shows the coastline, major rivers like the Columbia and Cowlitz, and various survey lines. The text is overlaid on the map in a large, bold, blue font with red highlights on certain words. The map itself is a sepia-toned historical document with a grid of survey lines and various geographical features labeled.

**Spatial Reference Center of Washington**  
**Earthscope's Plate Boundary Observatory**

**Puget Reference Station Network**

**Pierce County CORS Infrastructure**

**GPS User Groups**

**Guidelines for Land Surveying Using GPS**

**Tri-Cities - Spokane - Wenatchee**

**Vancouver - Portland**

# The Spatial Reference Center of Washington (SRCW)



# SRCW - The Spatial Reference Center of Washington

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- A **member driven** non-profit organization housed at the Dept. of Natural Resources in Olympia, Wa.
- End Goal - An accurate and precise GPS based reference frame for the entire state.
- Accomplished via traditional leveling and GPS techniques.
- Members and partners from various private groups, and local, state and federal agencies.



# SRCW - The Spatial Reference Center of Washington

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## ***Current Members:***

Washington Dept. of Transportation (WASHDOT), National Geodetic Survey (NGS), Washington Dept. of Natural Resources (DNR), Licensed Surveyor's Association of Washington (LSAW), Renton Technical College, Washington Council of County Surveyors (WCCS), Pierce County, City of Seattle & Seattle Public Utilities, Snohomish County, Thurston County, City of Renton, ESRI, Geoline Positioning Systems, Puget Reference Station Network (PRSN)

## ***Partnerships:***

U.S. Geological Survey: Cascade Volcano Observatory (CVO), U of W, Plate Boundary Observatory, Unavco (PBO)  
Pacific Northwest Geodetic Array (PANGA), CWU  
California Spatial Reference Center, Washington Geographical Information Council (WAGIC), American Society for Photogrammetry and Remote Sensing (ASPRS), Washington Dept. of Ecology



**What Else Can We Do With a Super-Collider?**

# Civil GPS Use

**Power Grid  
Interfaces**



**Personal Navigation**



**Trucking &  
Shipping**



**Surveying &  
Mapping**



**Communications --  
Network  
Synchronization  
and Timing**



**Aviation**



**Recreation**



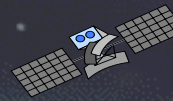
**Railroads**



**Fishing &  
Boating**



**Off shore  
Drilling**

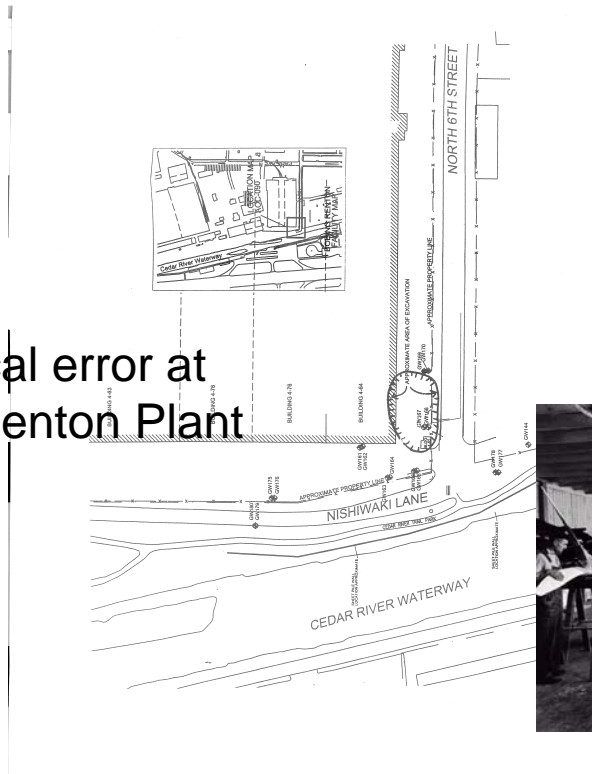


**Satellite Ops --  
Ephemeris,  
Timing**

# Why Height Modernization in Washington State?

Evidence suggests severe height errors with benchmarks...

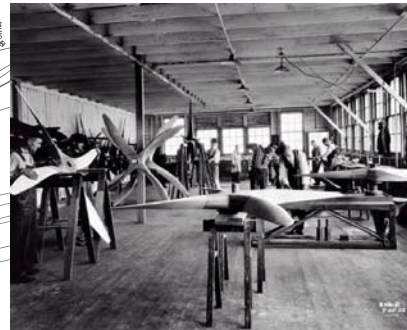
18" vertical error at  
Boeing Renton Plant

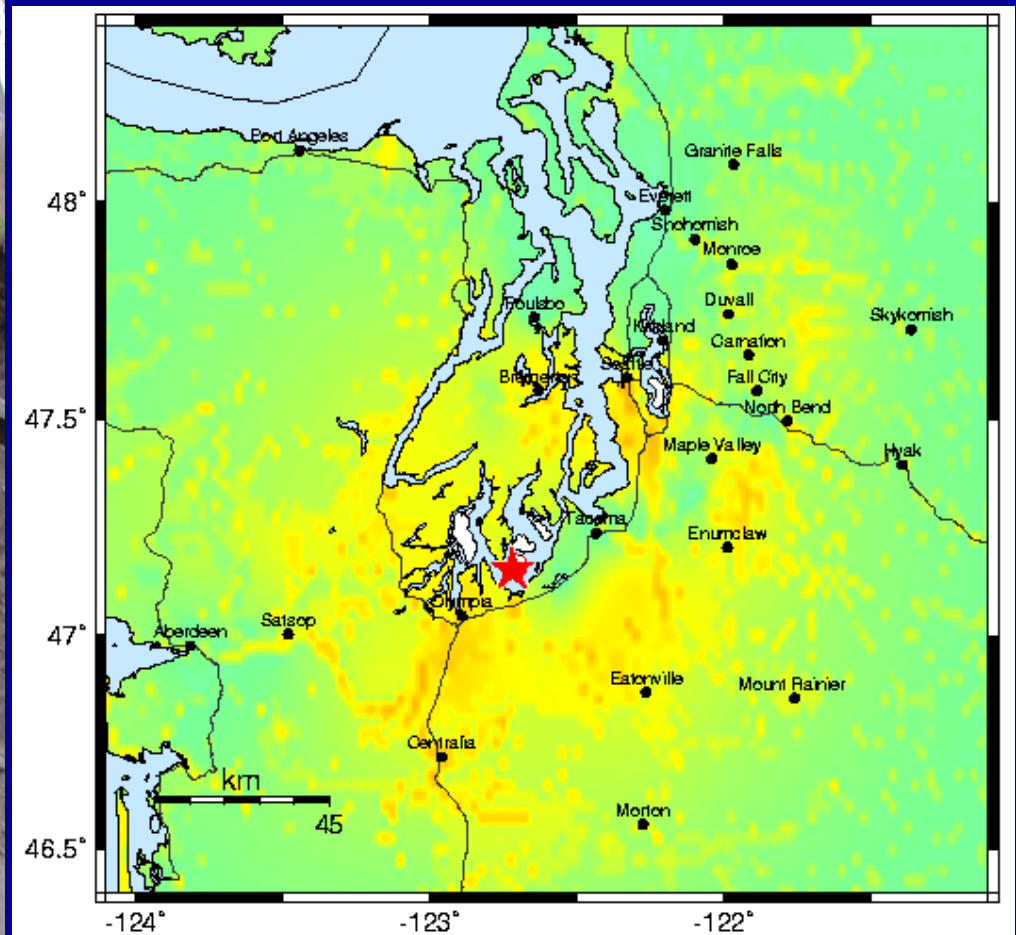


Port of Tacoma



1/2 ft. differential  
vertical error between  
two sides of bay





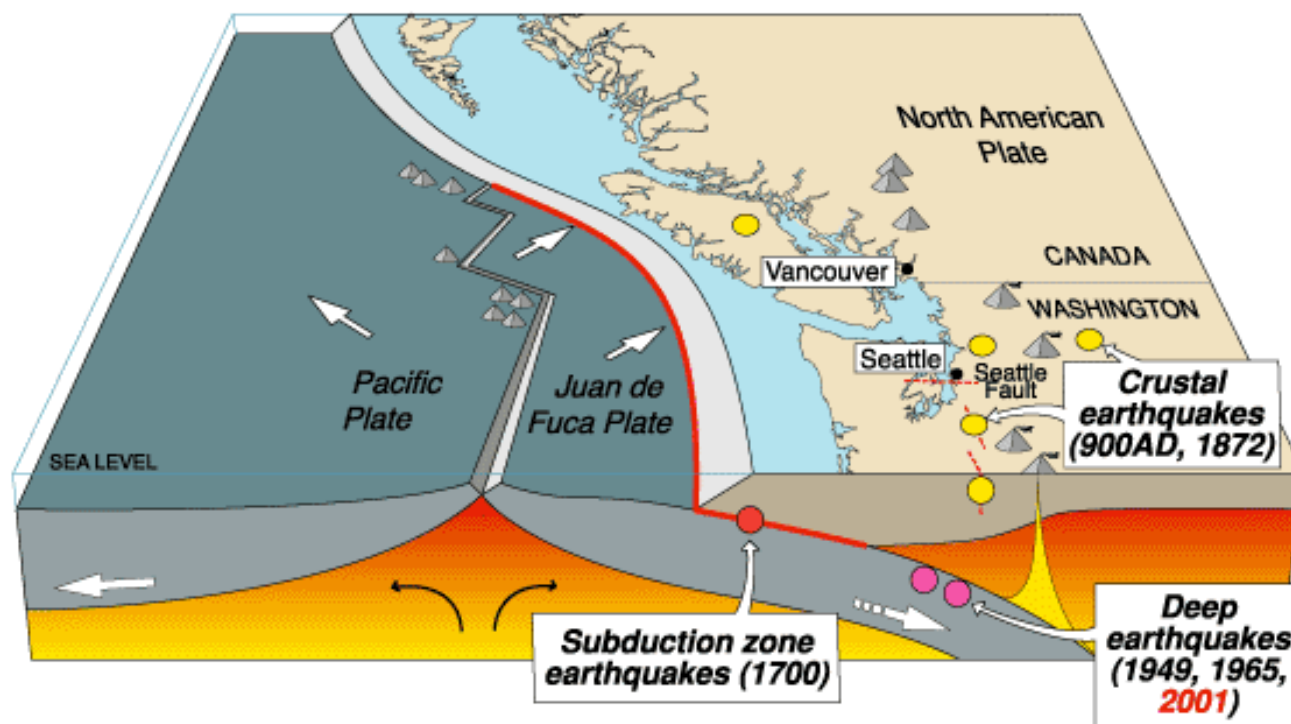
## Nisqually earthquake

February 28, 2001

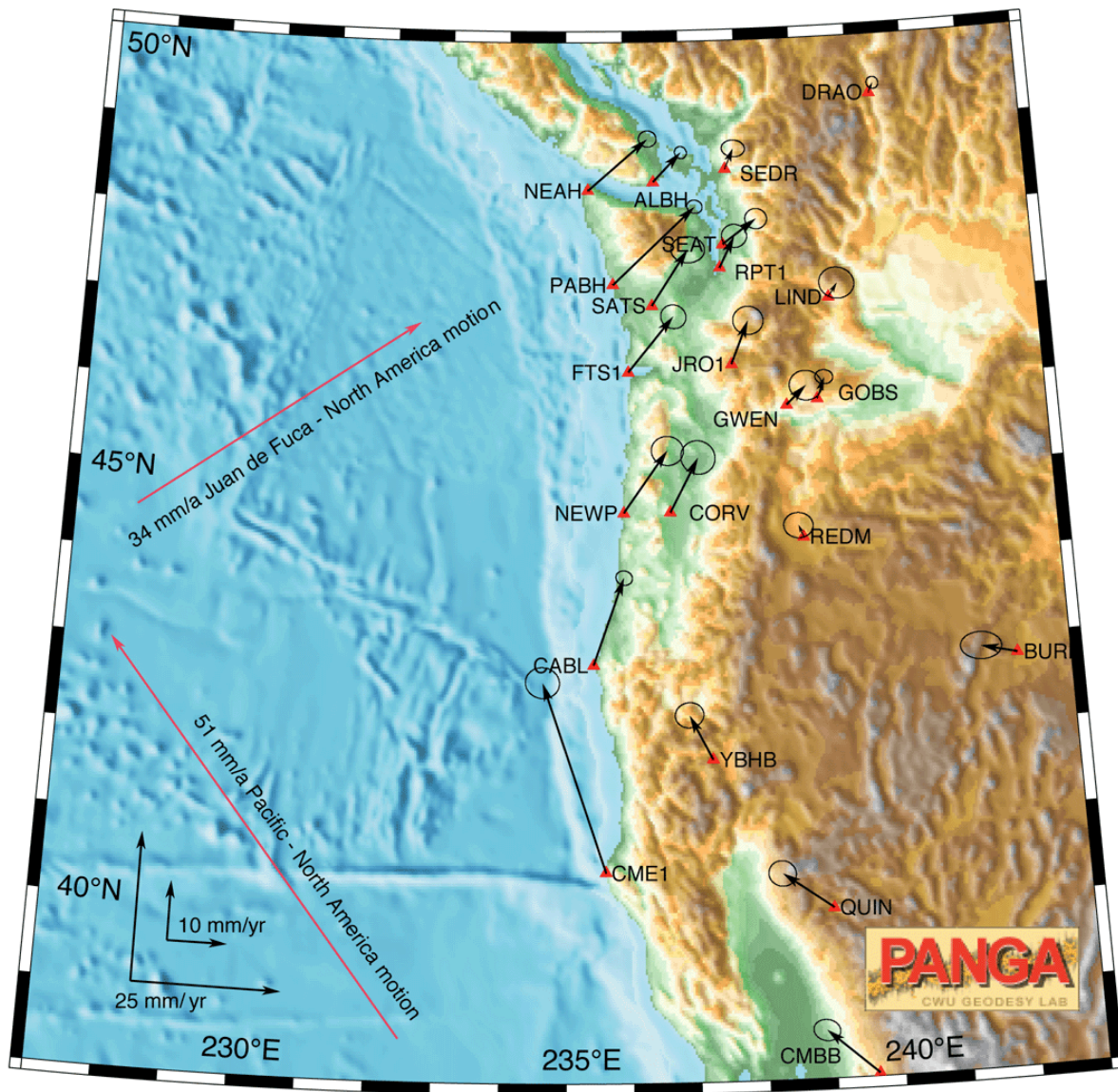
10:54 AM

Magnitude (M<sub>w</sub>) 6.8

## Cascadia earthquake sources



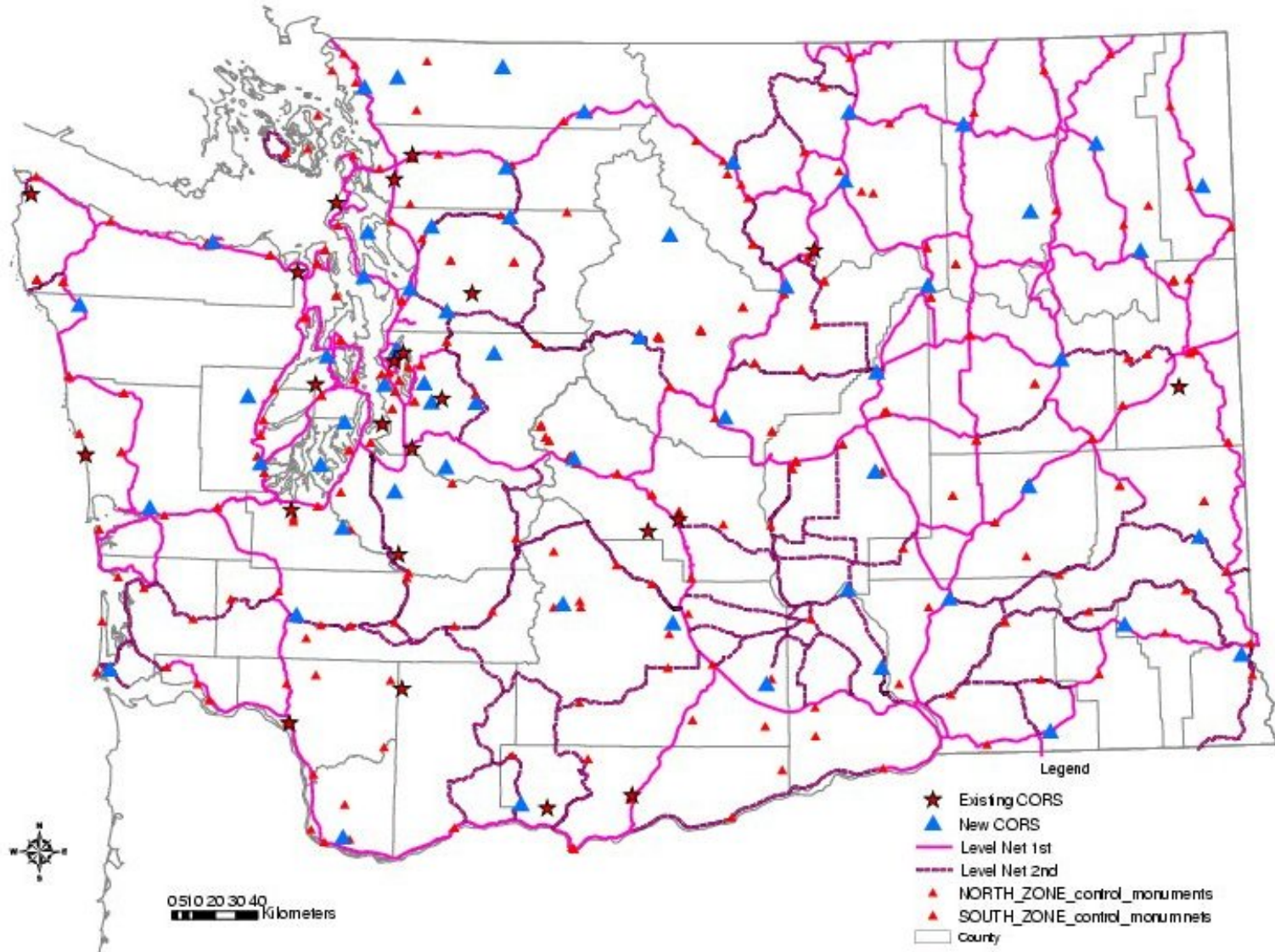
| Source                    | Affected area | Max. Size | Recurrence      |
|---------------------------|---------------|-----------|-----------------|
| ● Subduction Zone         | W.WA, OR, CA  | M 9       | 500-600 yr      |
| ● Deep Juan de Fuca plate | W.WA, OR,     | M 7+      | 30-50 yr        |
| ● Crustal faults          | WA, OR, CA    | M 7+      | Hundreds of yr? |

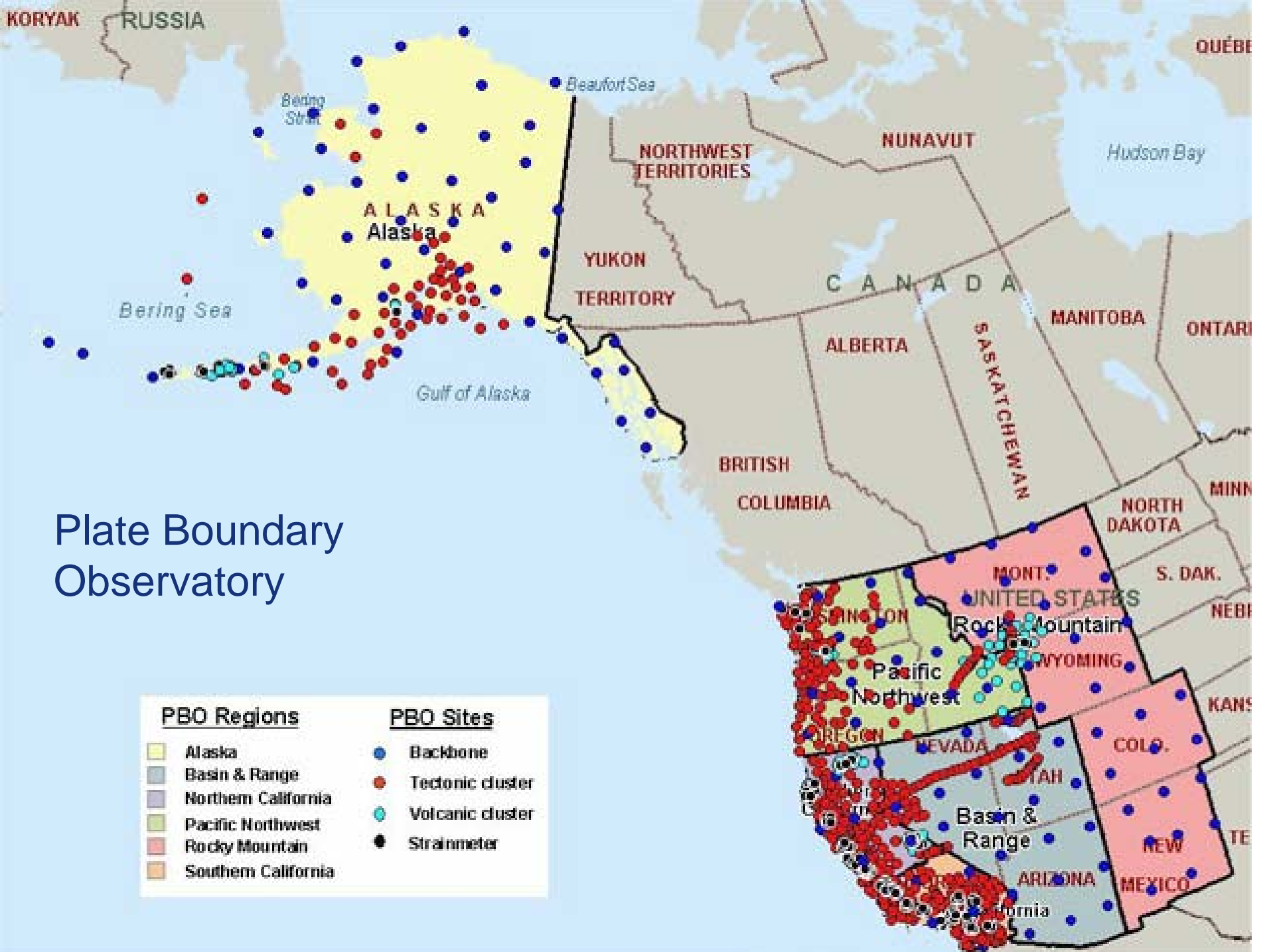


Source: Pacific Northwest Geodetic Array, CWU

# WAHMP Proposed Level Lines and GPS Infrastructure

## Spatial Reference Center of Washington

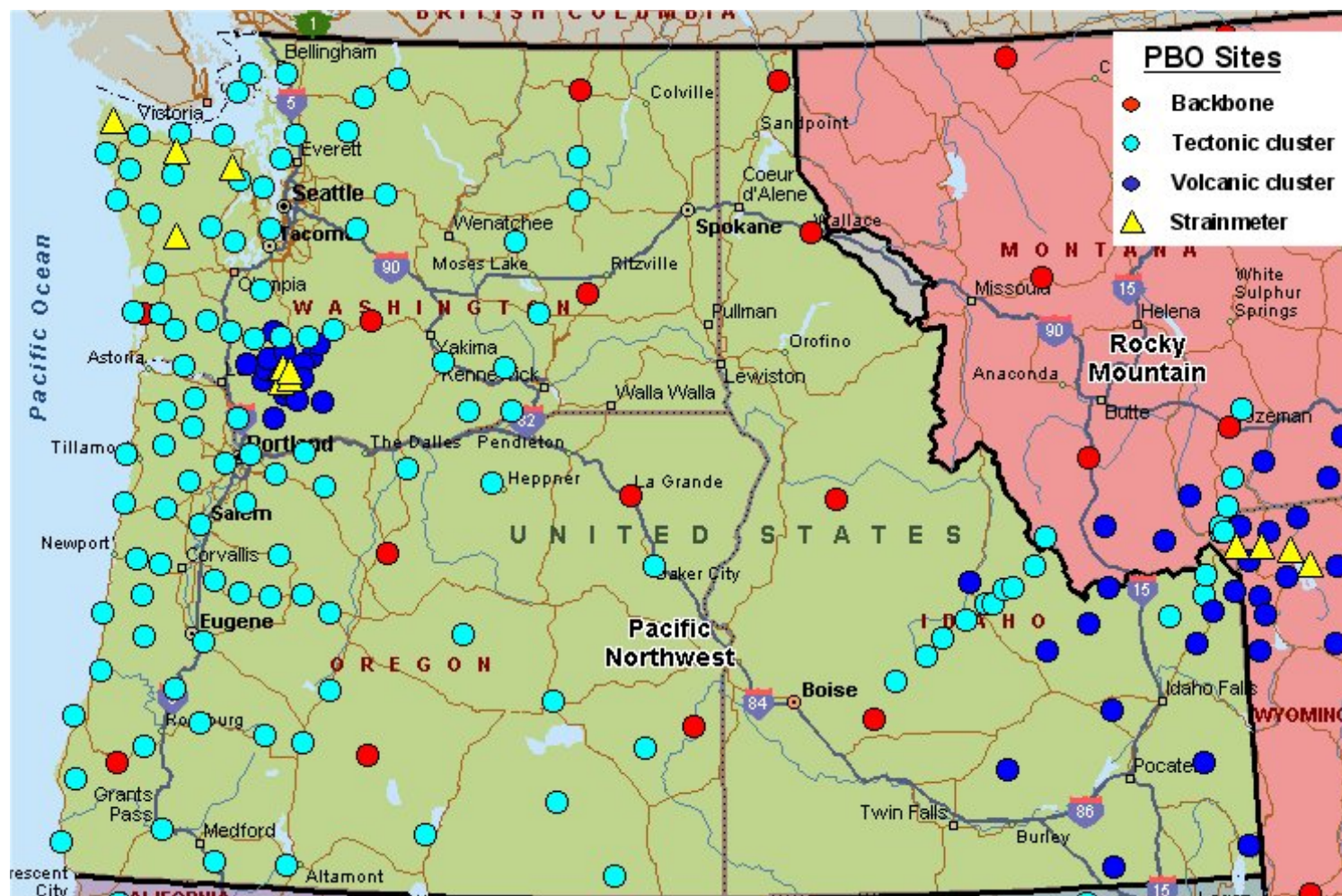




## Plate Boundary Observatory

# Plate Boundary Observatory

## *Pacific Northwest Region*

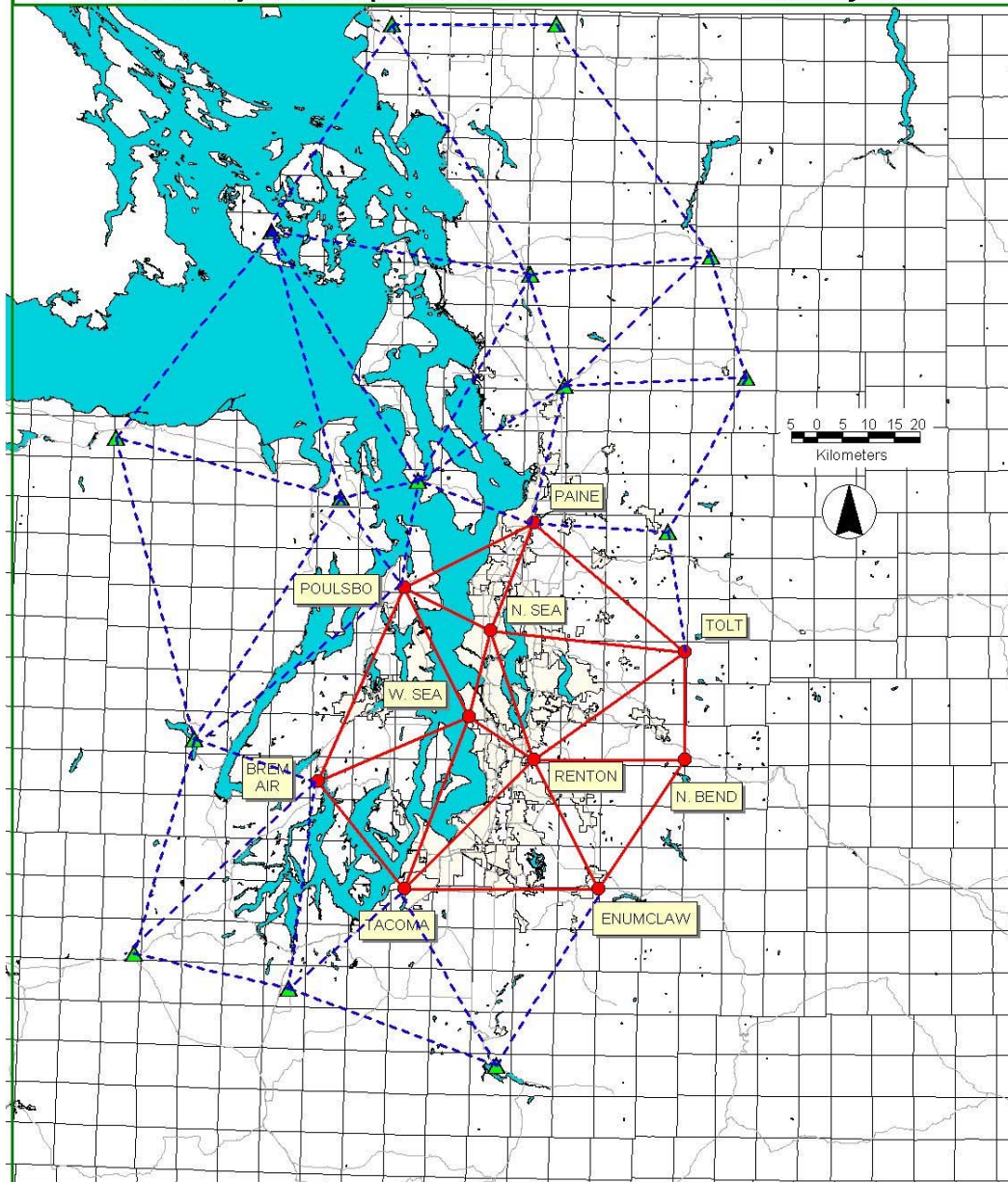


# Puget Reference Station Network

## Regional Network - Expansion Beyond Core Funded by Others

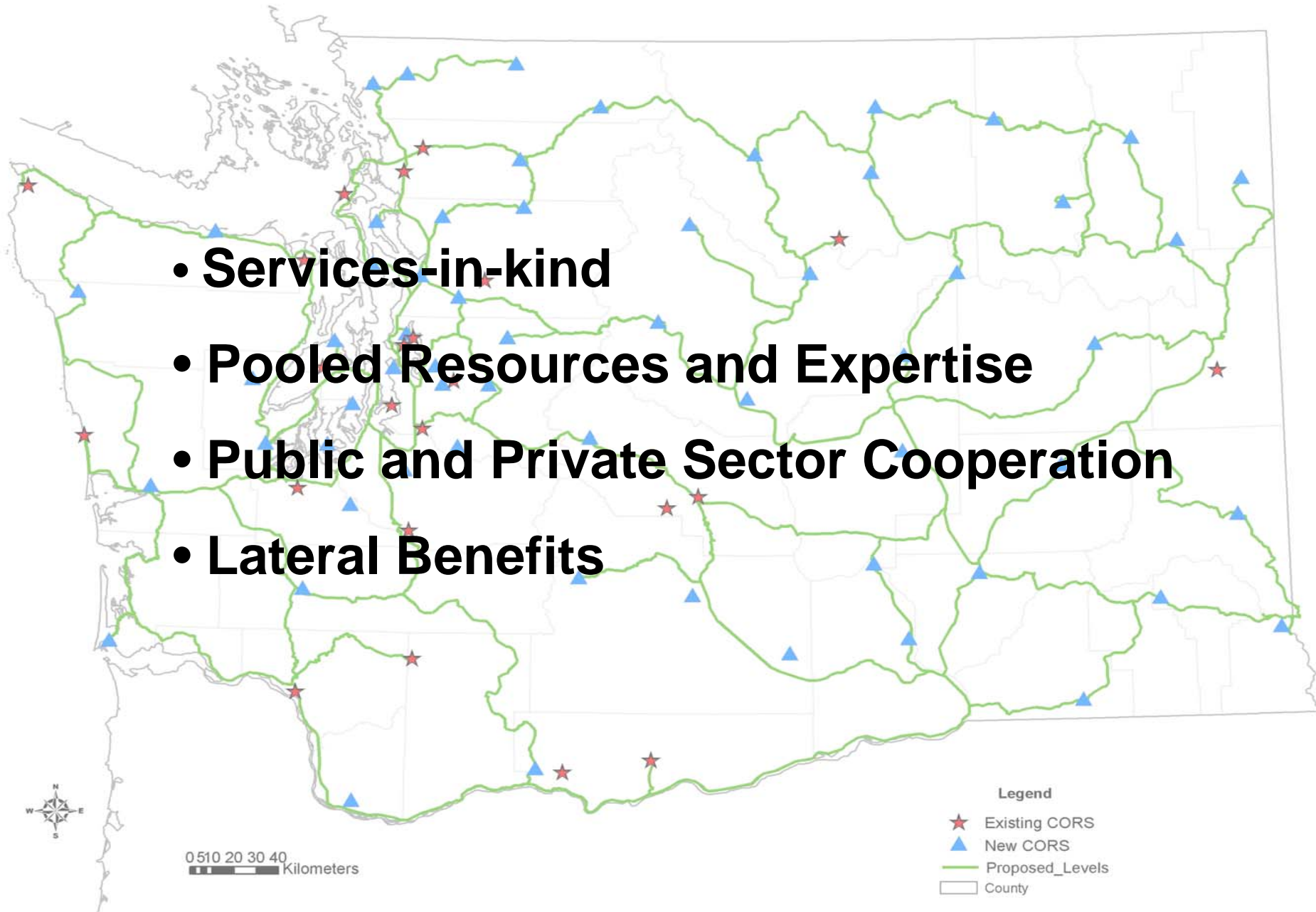
SPU Project Development Plan

January 2004

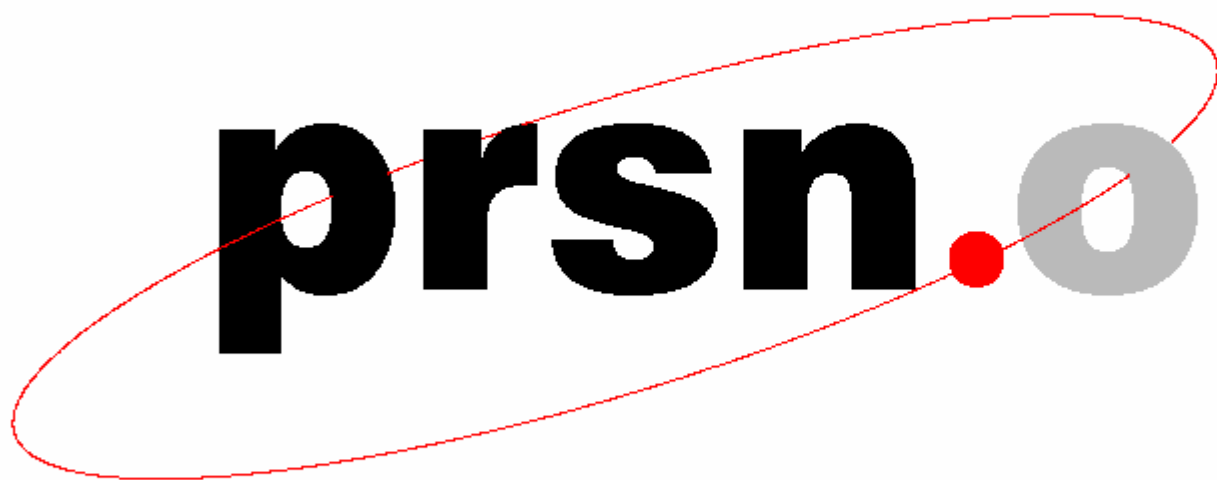


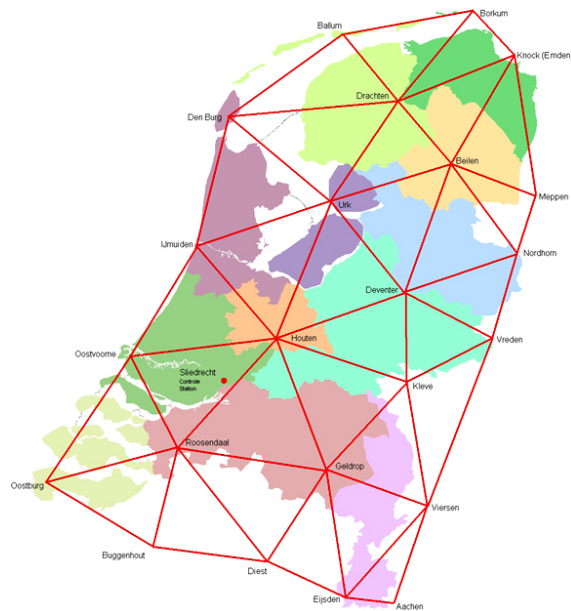
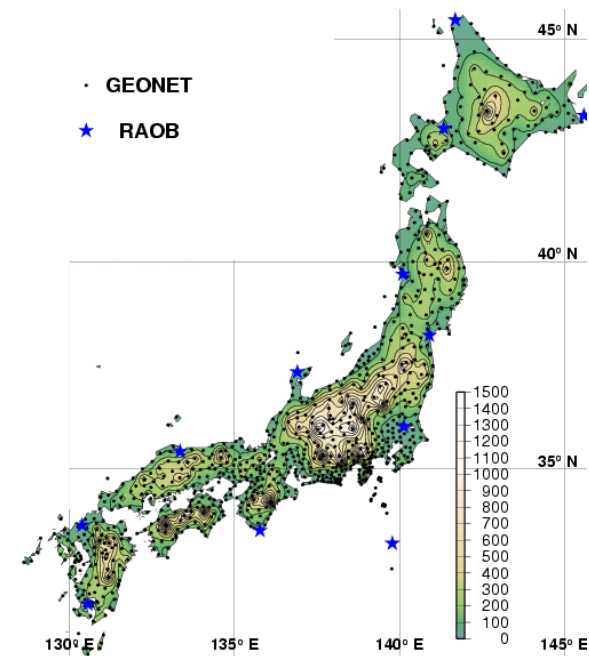
# Spatial Reference Center of Washington

- **Services-in-kind**
- **Pooled Resources and Expertise**
- **Public and Private Sector Cooperation**
- **Lateral Benefits**



**prsn.**org





# **PUGET REFERENCE STATION NETWORK**

## **PRSN**

**A cooperative system that delivers survey data  
and real-time GPS corrections in the Puget  
Sound Region from a network of base stations.**

# PRSN Players

- City of Seattle
- Snohomish County
- Metro - King County
- City of Renton
- Kitsap PUD
- WSDOT
- Thurston County
- UW and CWU
- WADNR
- Island County
- Skagit County
- Pierce County



# Pilot Networks

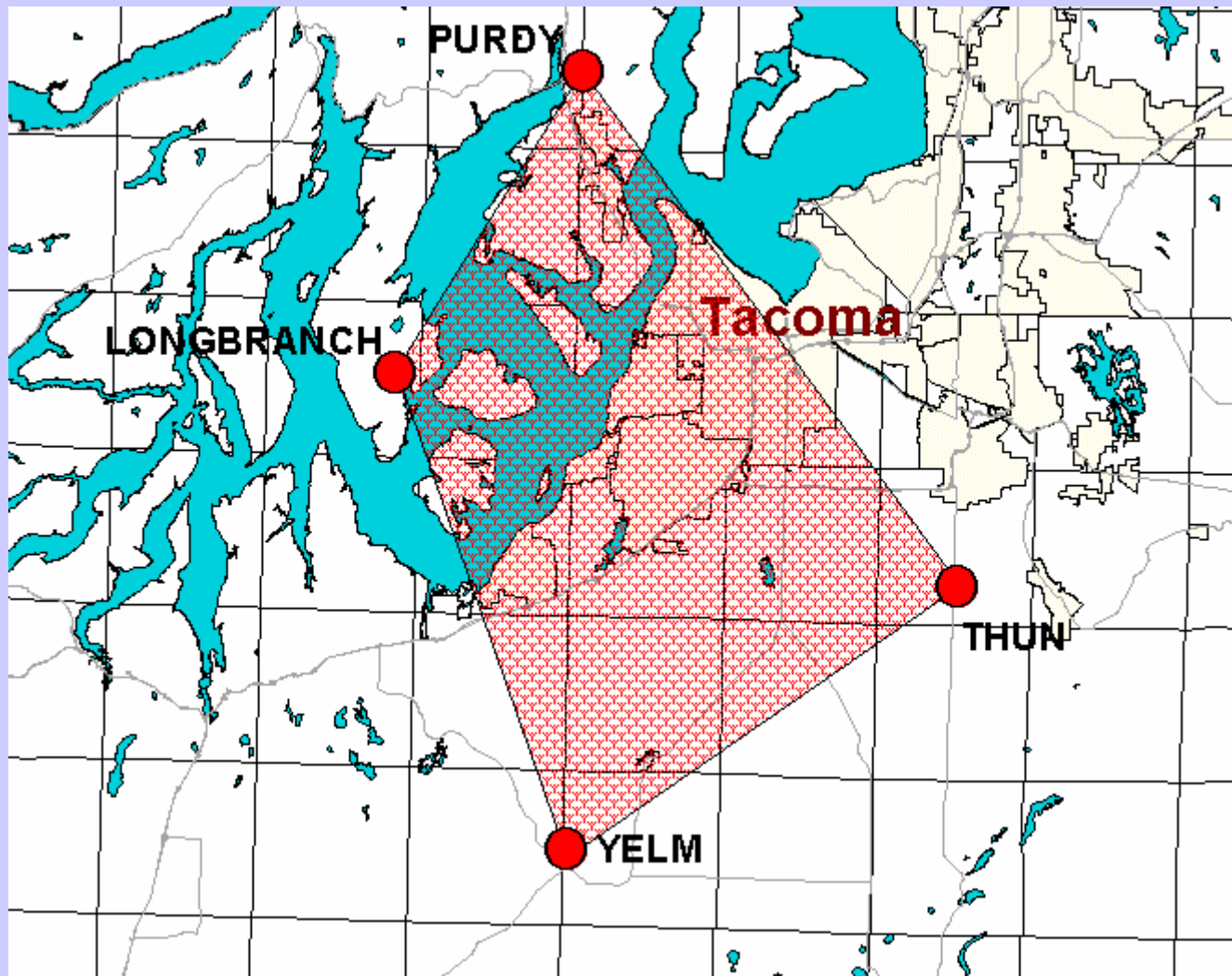


# Pierce County Public Works



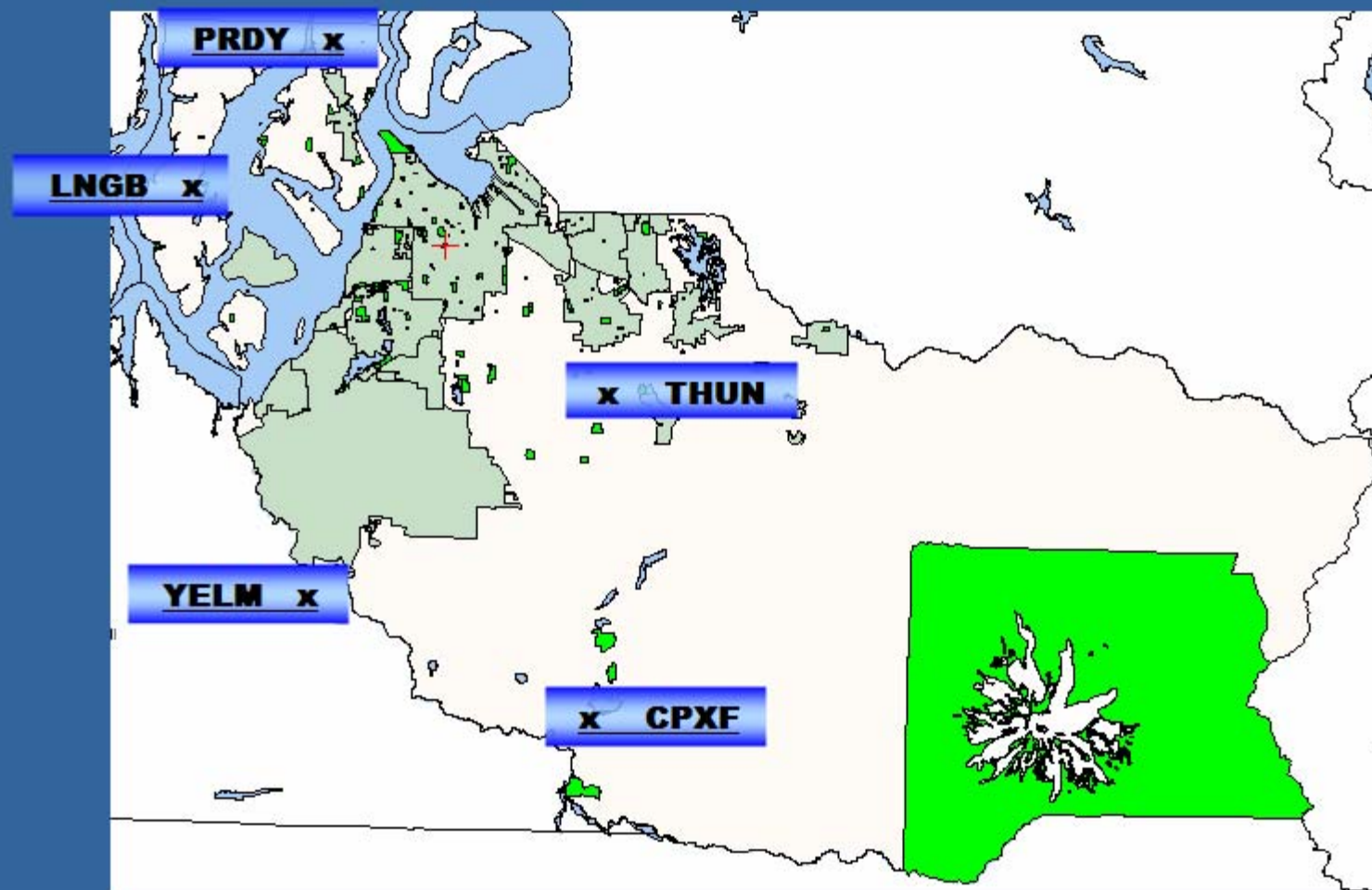
**GPSNet Pilot - June 2003**

# Pierce County Pilot Network - June 2003



# ***Welcome to the Pierce County CORS website!***

*Hover and click over any of the sites shown below to link to their site information and data.*



# Pierce County Network



In cooperation  
with the NGS  
Cooperative  
CORS program.



LINKS:

[Cooperative  
CORS](#)

[Northwest  
Region CORS  
Stations](#)

[PRSN](#)

## LNGB - Longbranch Fire Station



### GPS Site Information:

Site Name: Longbranch Fire Station

Site ID: LNGB

PID: DG6523 (ARP position)

NGS Coordinates NAD83CORS96) (epoch 2002.0):

Latitude: 47° 13' 07.61198" N

Longitude: 122° 45' 29.87627" W

Ellip. Hgt.: 2.796m (at ARP)

Pierce County Coordinates NAD83 (HARN91): **Final**

Latitude: 47° 13' 07.60964" N

Longitude: 122° 45' 29.87801" W

Ellip. Hgt.: 2.839m (at ARP, Geoid 99)

Northing: 695612.404 fts

Easting: 1079304.458 fts

Ortho. Elev.: 82.860 fts (at ARP, NAVD88)

Location: Longbranch, Washington

Organization: Pierce County Public Works, Survey Section

### GPS Receiver Specifications:

Manufacturer: Leica Geosystems

Antenna: LEIAT504 LEIS (IGS Type T Choke Ring L1/L2 antenna with radome)

Elevation Mask: 10 Degrees

Operation Time: 24x7 log files

File Types: Rinex, Leica MDB, RTK CMR

Receiver Model: Leica RS500

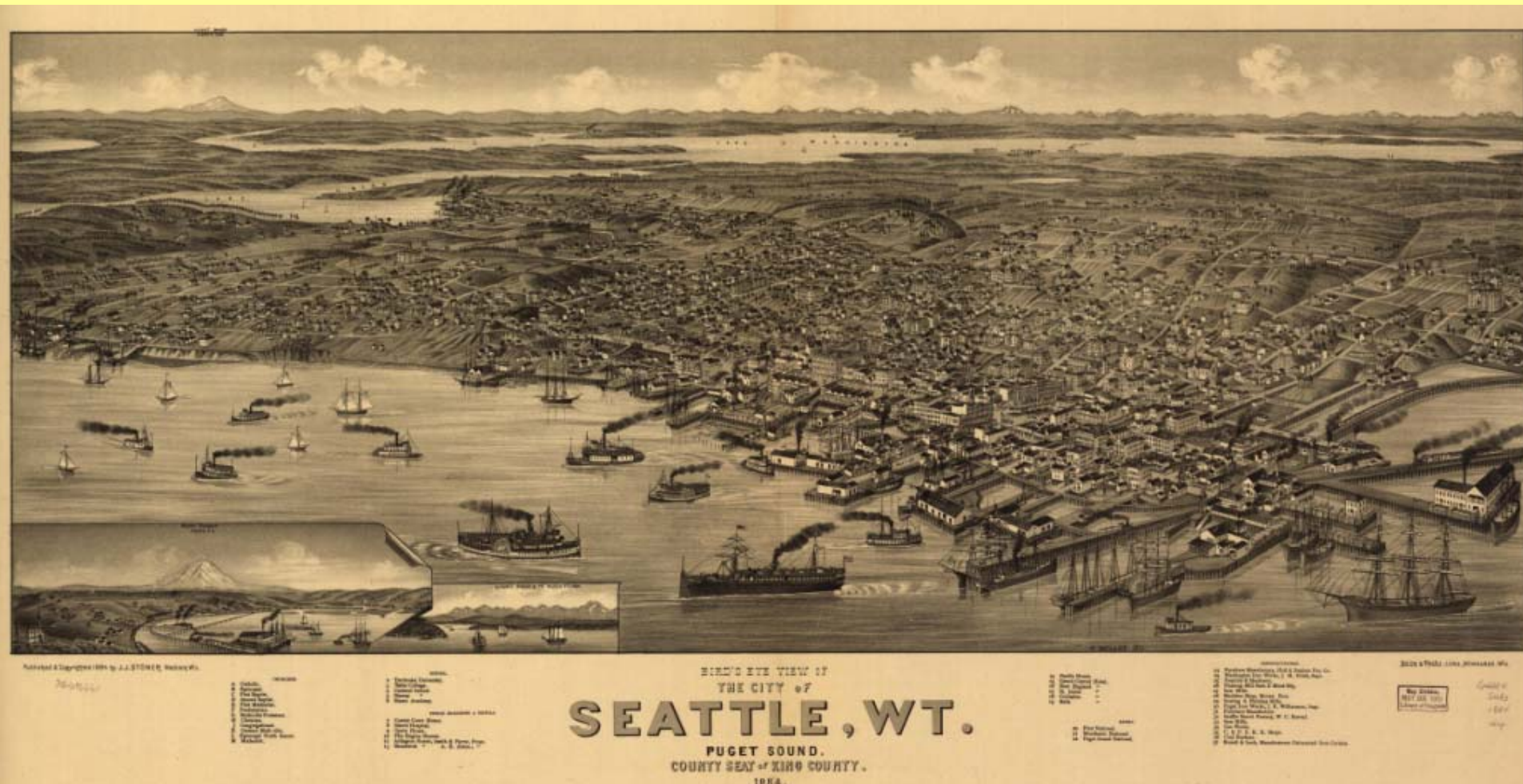
Logging Interval: 10 Second

Rollover: Hourly

[NGS COORDINATE REPORT  
SITE LOG](#)



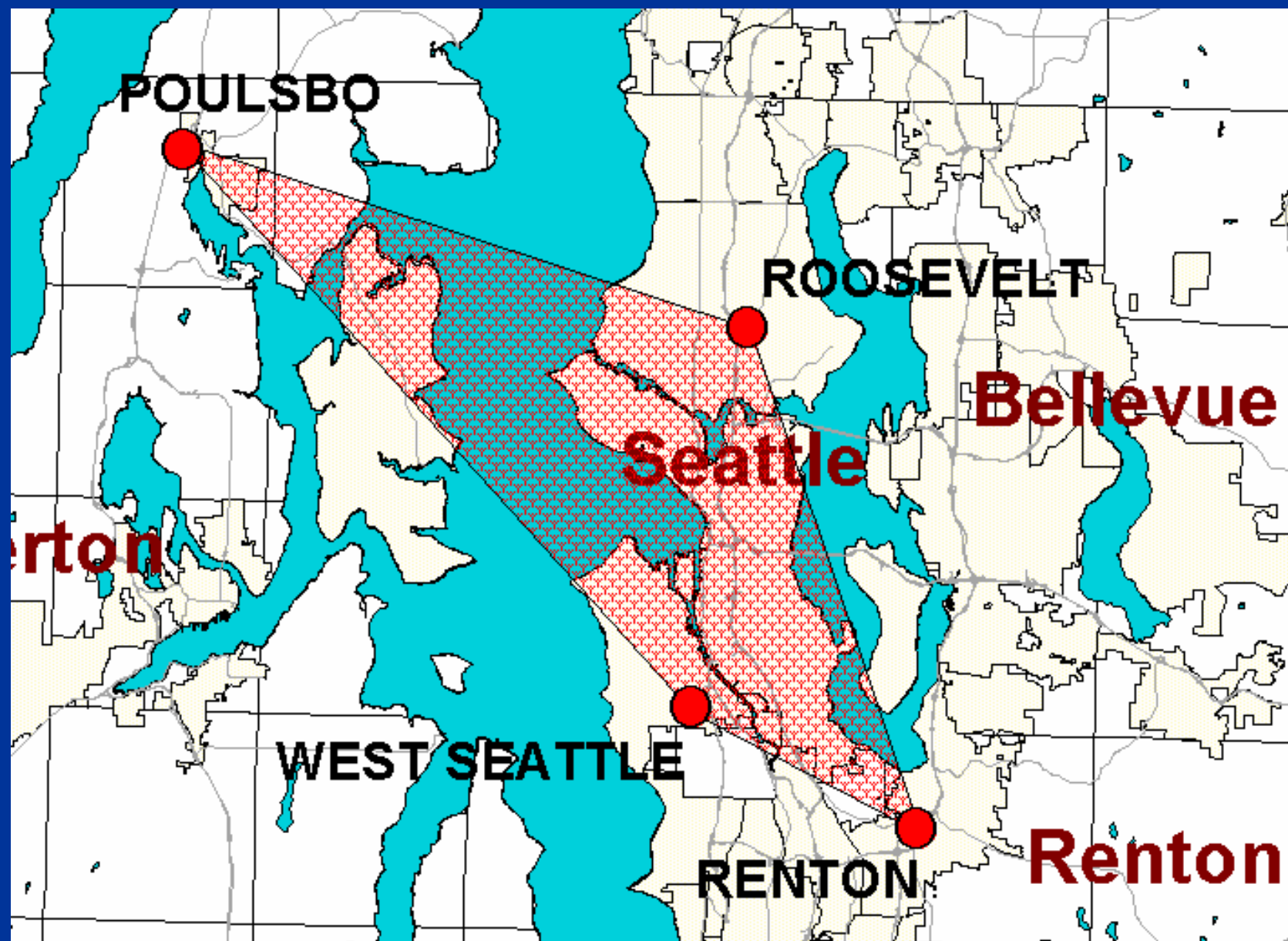
# Seattle Public Utilities



## GPSNet Pilot - Nov 2002



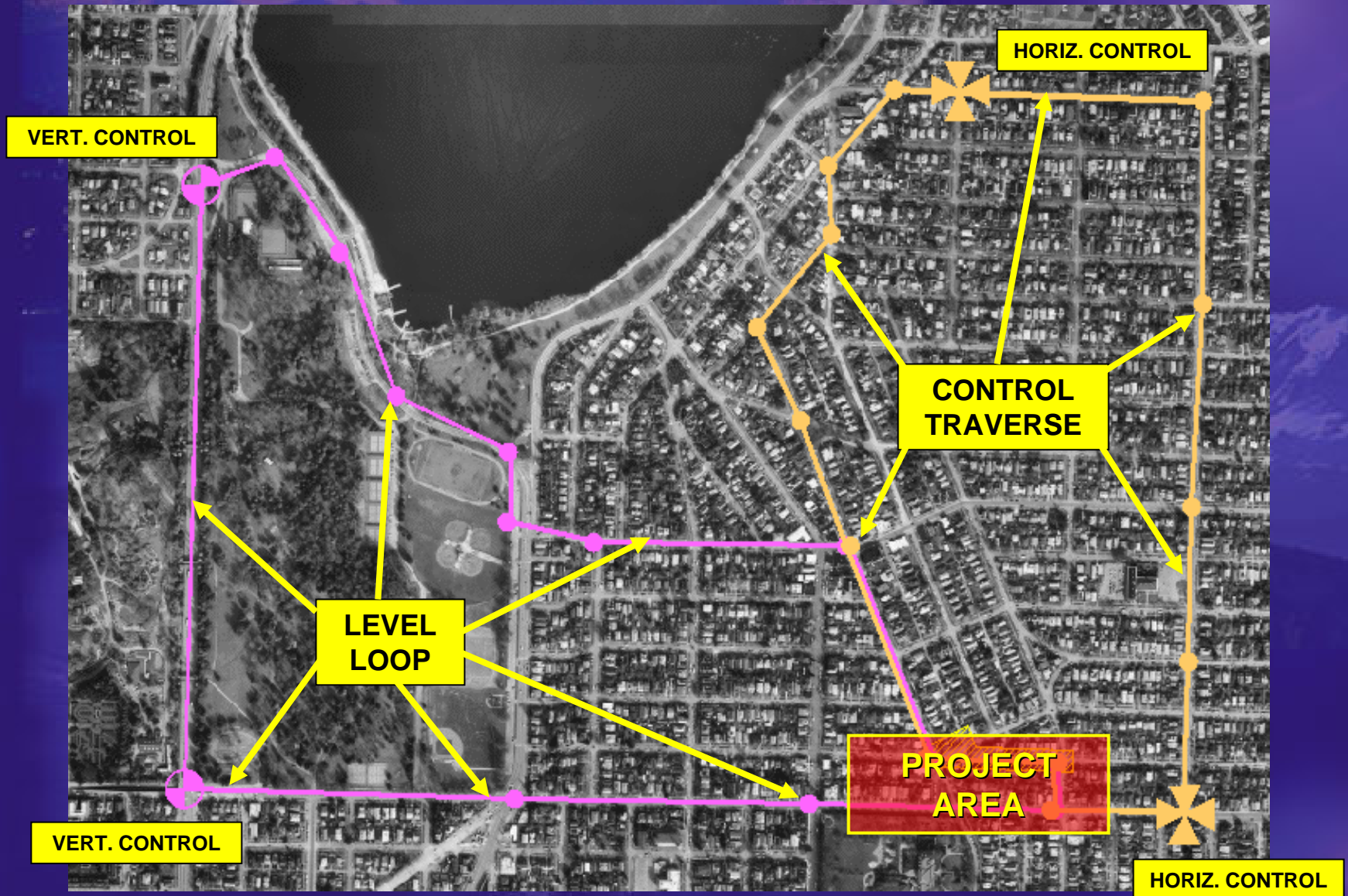
## Seattle Public Utilities Pilot Network - Nov 2002





# Conventional Survey Example

Establishing Horizontal and Vertical Control for a Typical CIP Project





# ECONOMIC ANALYSIS

## Control Surveys

### Conventional Control Surveys:

|                   |                        |
|-------------------|------------------------|
| 12 conventional = | \$56,332               |
| 16 static GPS=    | \$39,121               |
|                   | <b><u>\$95,454</u></b> |

### Utilizing the Pilot Network:

|                         |                        |
|-------------------------|------------------------|
| 20 VRS mode=            | \$8,662                |
| 8 GPS static w/network= | \$8,154                |
|                         | <b><u>\$16,822</u></b> |

**Net Yearly Savings= \$78,631**



# ECONOMIC ANALYSIS

## Project Costs and Benefits:

|                                   |                       |
|-----------------------------------|-----------------------|
| Capital Costs                     | \$301,950 (2004-2015) |
| Operating/Maintenance costs       | \$358,760 (2004-2015) |
| <b>Net Present Value (NPV) 3%</b> | <b>\$1,469,641</b>    |
| Net Present Value (NPV) 5%        | \$1,287,401           |
| Net Present Value (NPV) 7%        | \$1,134,623           |

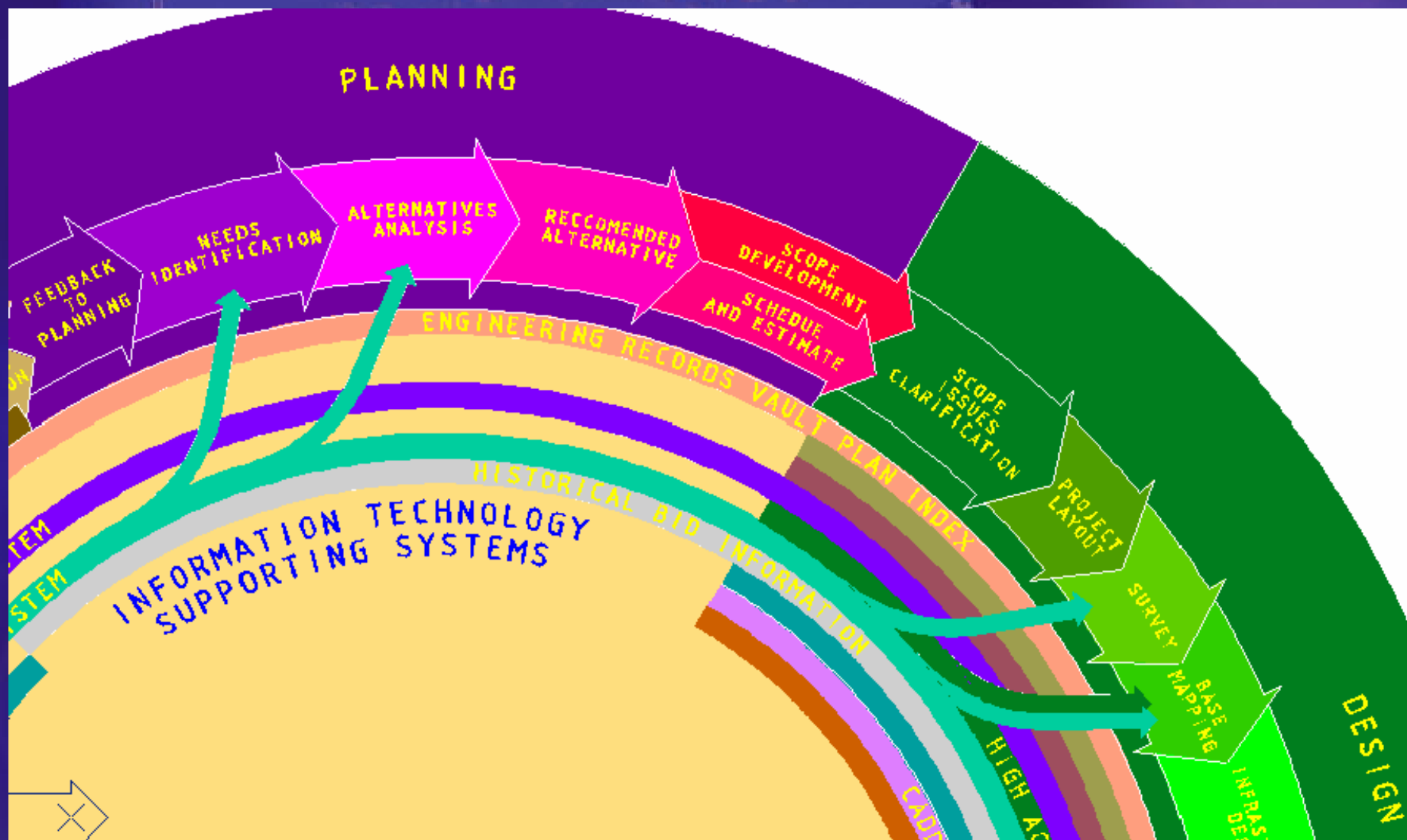
## CIP & O&M Budget Impact

| Adopted Budget / 6yr CIP \$ Amount | 2004     | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   | 2011   | 2012   | 2012 - 2015   | Total Project Cost |
|------------------------------------|----------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|--------------------|
| CIP                                | 92,800   | 67,650 | 15500  | 14000  | 14000  | 14000  | 14000  | 14000  | 14000  | 14000 per yr  | 301,950            |
| O&M                                | 92,650 * | 1,110* | 26,500 | 26,500 | 26,500 | 26,500 | 26,500 | 26,500 | 26,500 | 26,500 per yr | 358,760            |

\* Reflects yearly operating costs offset by partner contributions: \$20,000 in 2004 and \$25,000 in 2005



# Selling Point: Improved Geospatial Component for Enterprise Data







# Seattle Public Utilities

*“Cheap Mount”*

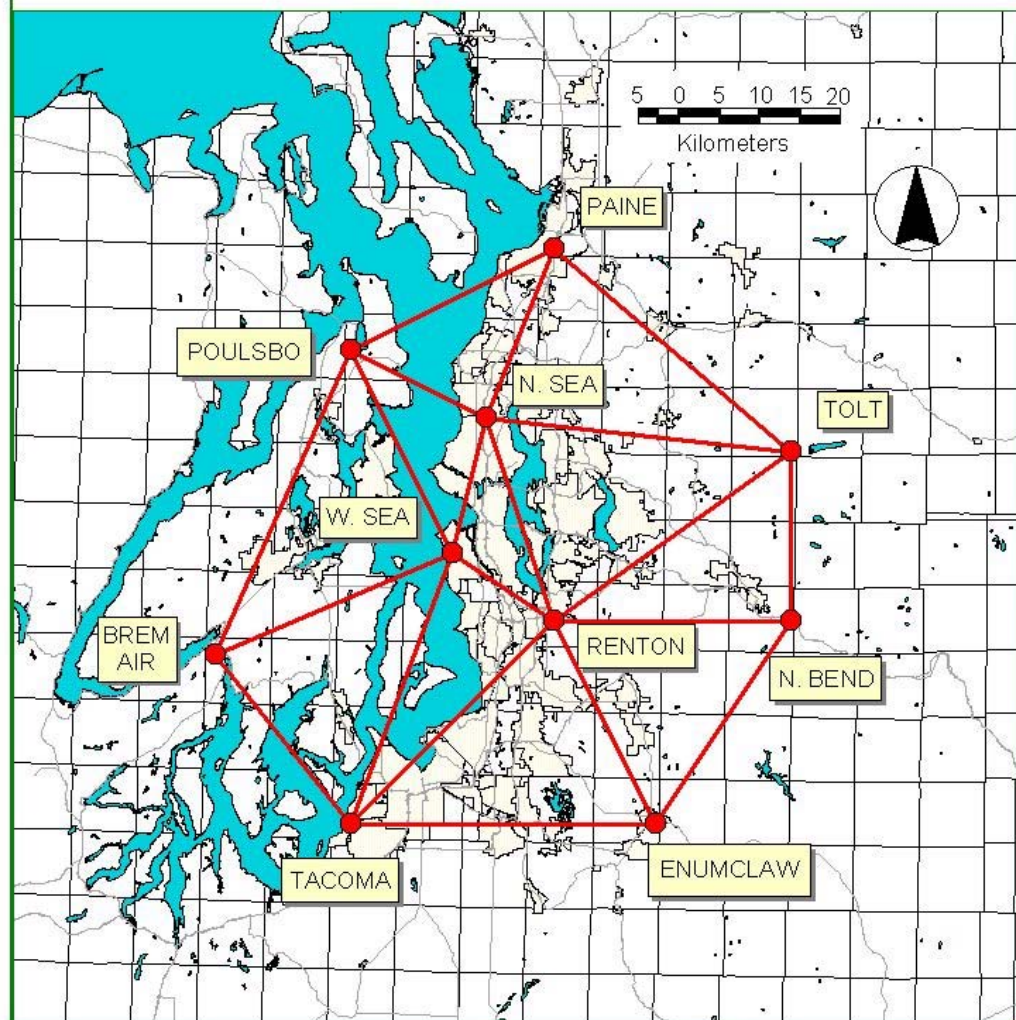




# Puget Reference Station Network Core Network

SPU Project Development Plan

January 2004



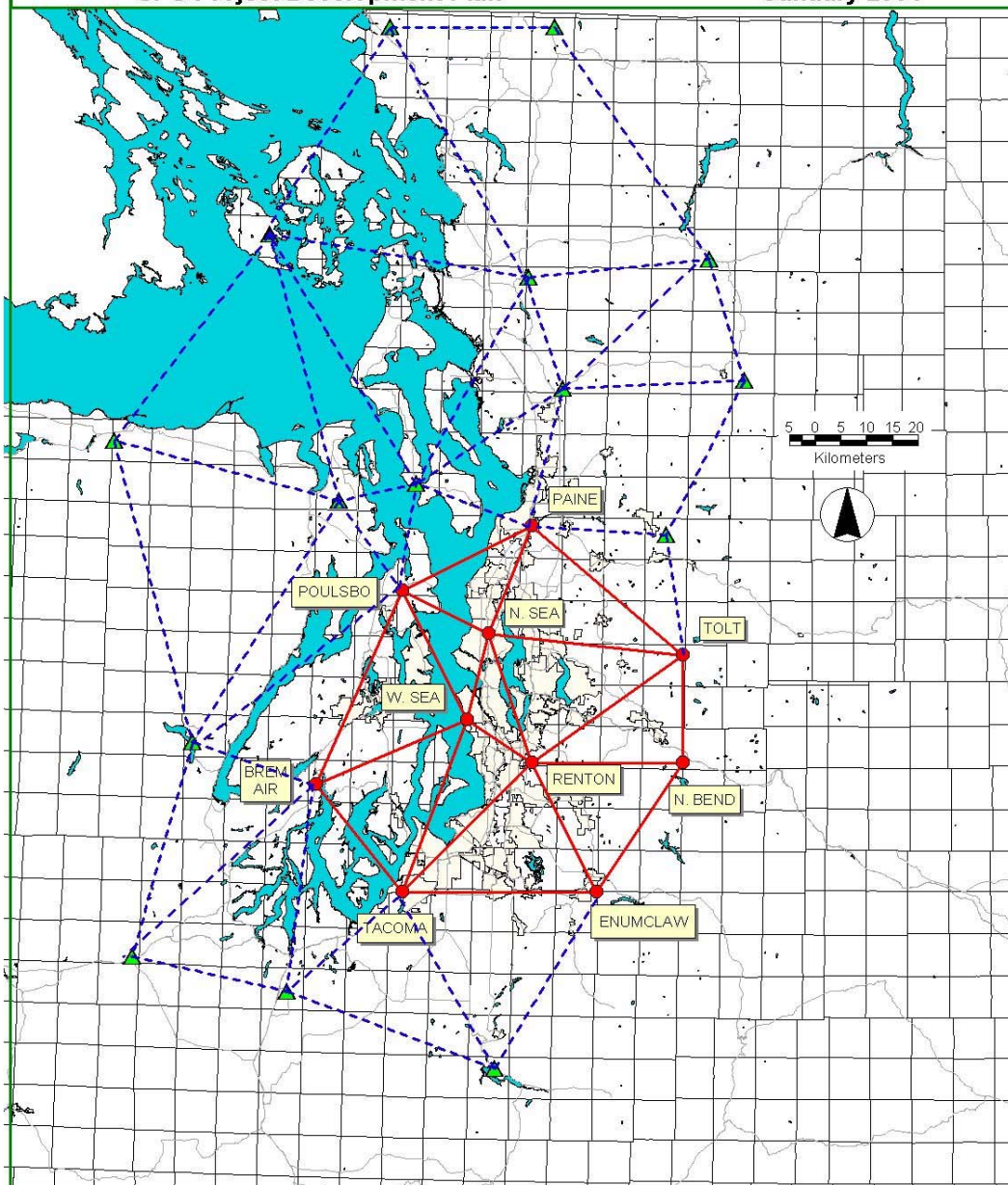


# Puget Reference Station Network

## Regional Network - Expansion Beyond Core Funded by Others

SPU Project Development Plan

January 2004



# PRSN Enhanced Web Services



## Puget Reference Station Network PRSN Reference Station Webserver

- [Home](#)
- [Map](#)
- [Almanac](#)
- [Ionosphere](#)
- [I95 Index](#)
- [Raw Data Download](#)
- [RINEX Service](#)
- [Virtual Data Download](#)
- [Satellite Tracking](#)
- [Logout](#)

- Layer
- ☐ Highways
  - ☒ PRSN Stations
  - ☒ PRSN Vectors
  - ☐ CORS Stations
  - ☐ Proposed SRCW Stations
  - ☐ Townships
  - ☐ Vertical Control
  - ☐ Horizontal Control
  - ☒ Counties

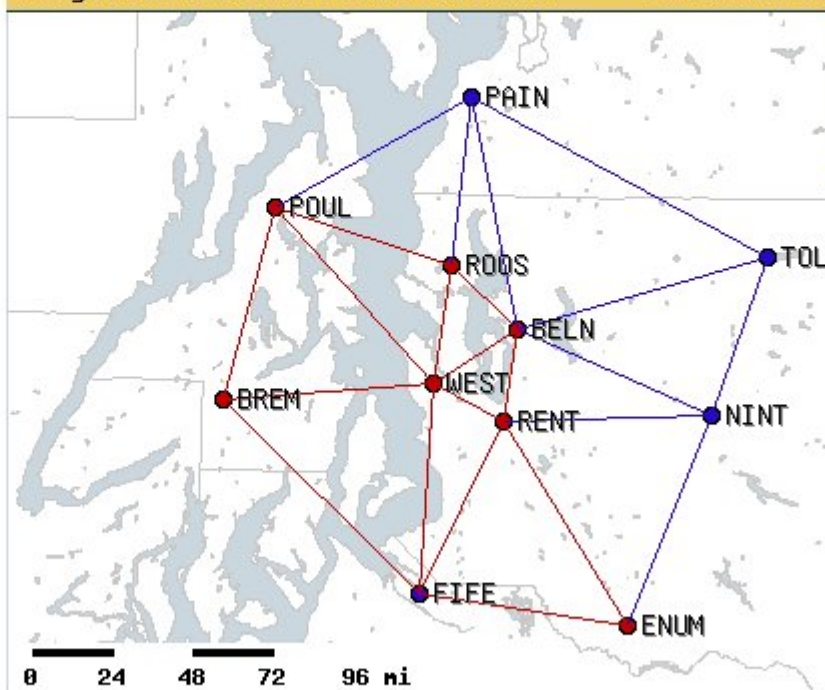
Query:

-Select-



Longitude: 1059182.47 to 1595153.87

Latitude: 442



# Open Source GIS Web Applications



## Puget Reference Station Network PRSN Reference Station Webserver

- [Home](#)
- [Map](#)
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### Layer

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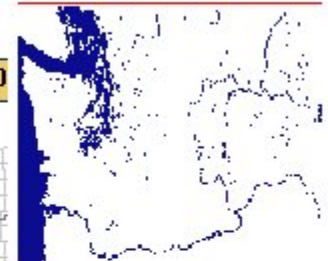
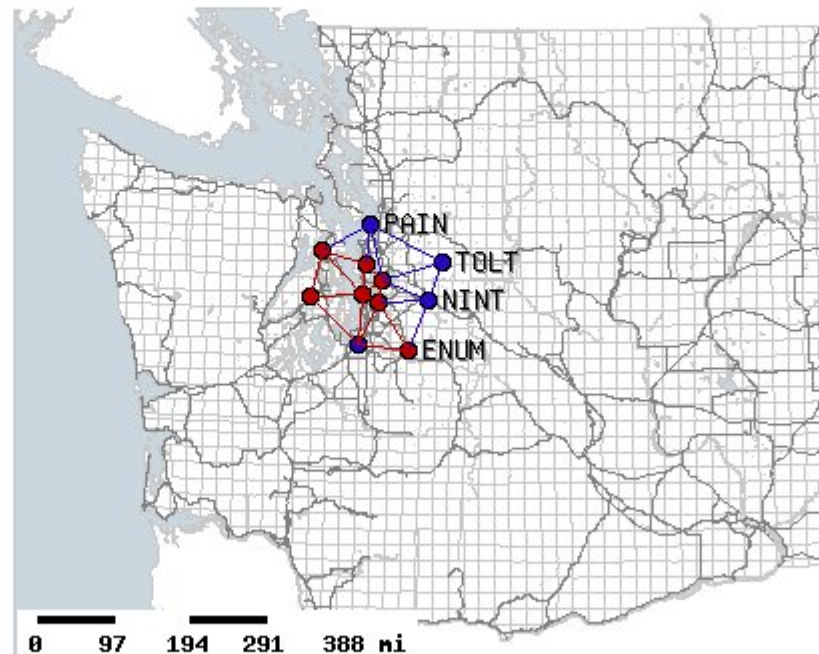
Query:

-Select-



Longitude: 550117.65 to 2779882.35

Latitude: -550



# Other CORS and Statewide Initiatives



## Puget Reference Station Network PRSN Reference Station Webserver

- [Home](#)
- [Map](#)
- [Almanac](#)
- [Ionosphere](#)
- [I95 Index](#)
- [Raw Data Download](#)
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- [Virtual Data Download](#)
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### Layer

- ☒ Highways
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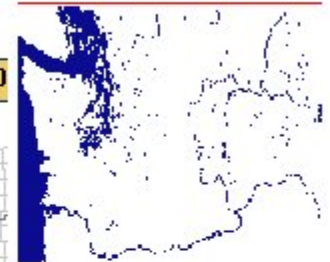
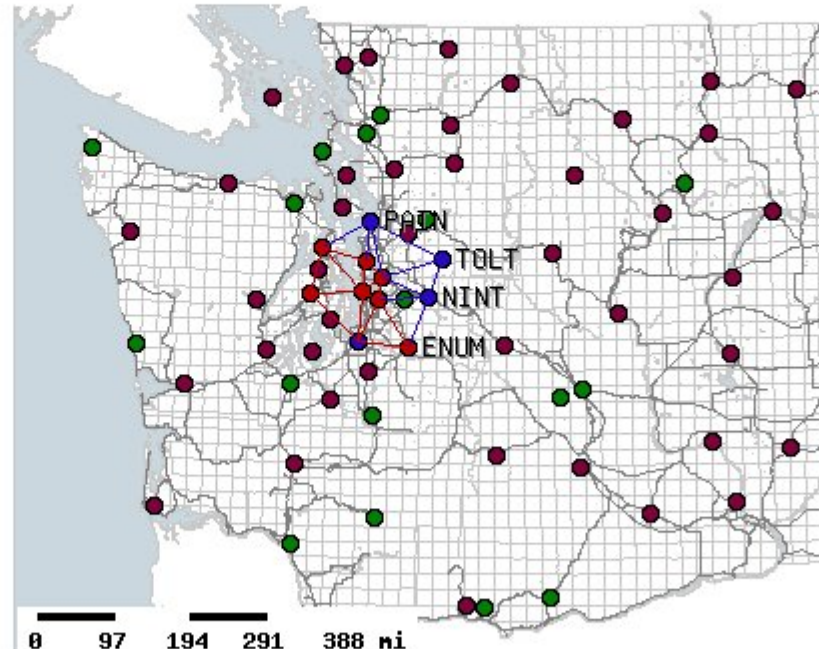
Query:

-Select-



Longitude: 550117.65 to 2779882.35

Latitude: -550





5000000000000000 386161.271000000000000000 Click [Here](#) for Sta



Trimble 4700

TRM33429.2+GP

0.000 ft

0.00 m

0.000 ft

0.000 m

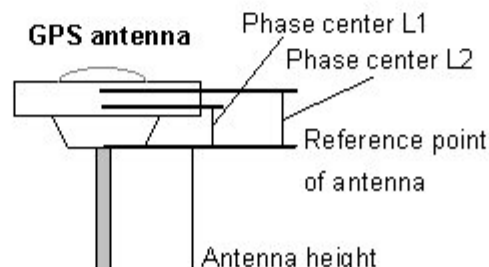
0.000 ft

0.000 m

Seattle Public Utilities

Roger Byarlay

roger.byarlay@seattle.gov



Reference Coordinate

HPGN

Washington State Plane

$$N = 194,650,051 \text{ ft.}$$
$$E = 1,266,930.757 \text{ ft.}$$
 $Z = 449.917$  (differentia

UTM - WGS84 datum

# Data from the State Control Warehouse



## Puget Reference Station Network PRSN Reference Station Webserver

- [Home](#)
- [Map](#)
- [Almanac](#)
- [Ionosphere](#)
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- [Raw Data Download](#)
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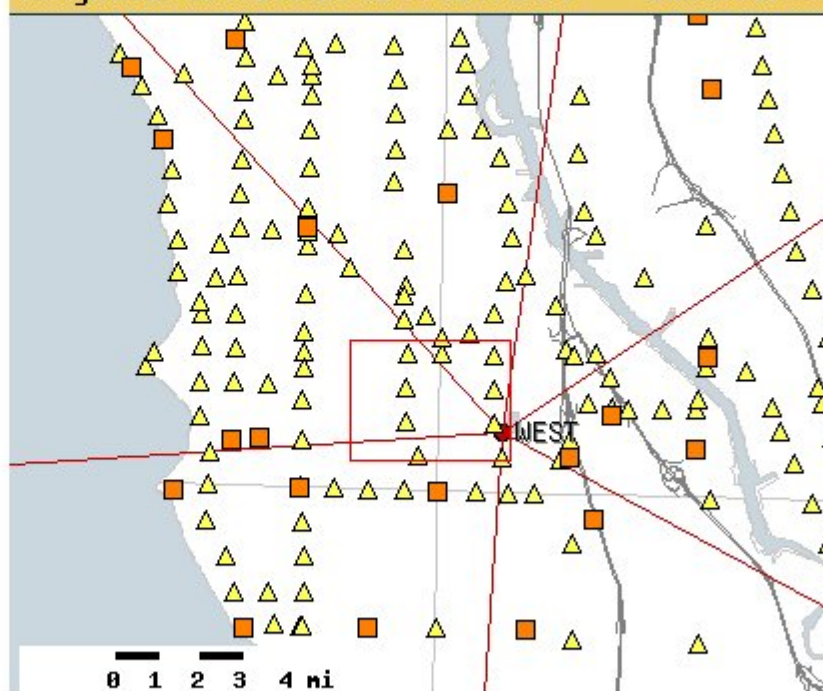
### Query:

-Select-



Longitude: 1247895.57 to 1290476.04

Latitude: 184



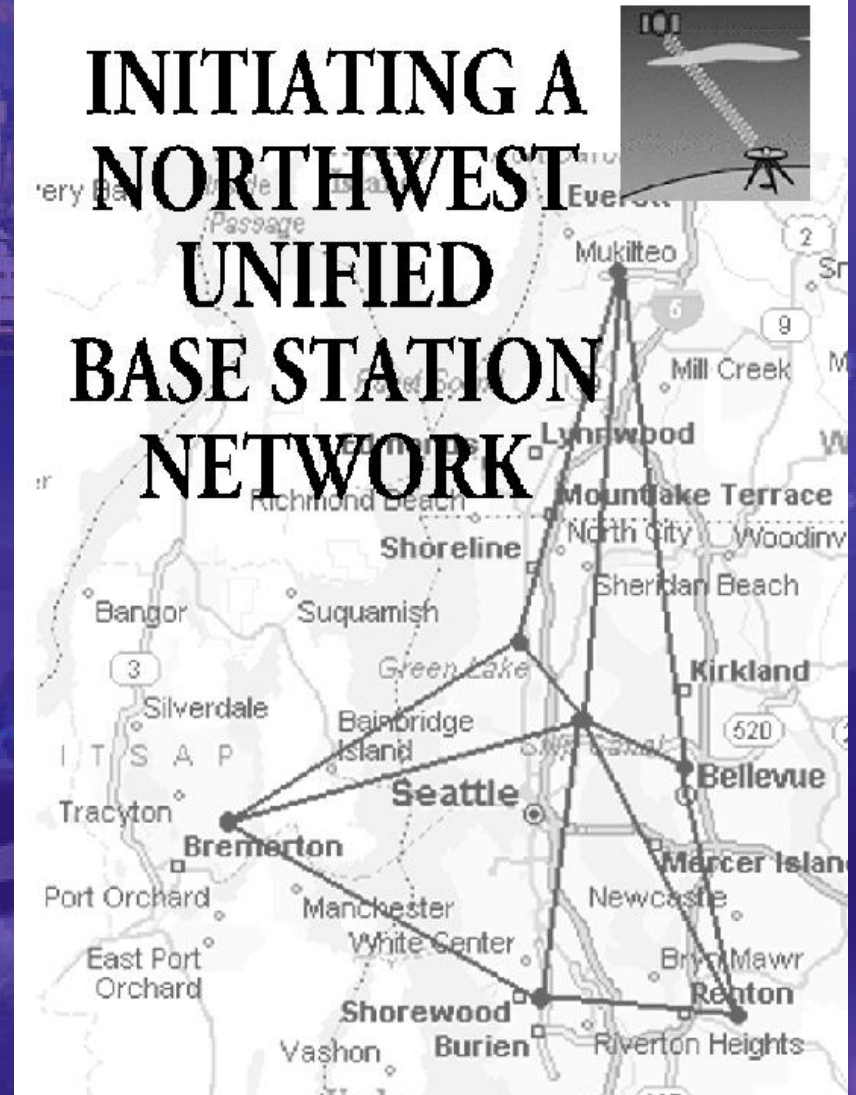
| Point ID | Designation | Northing  | Easting       | Latitude        | Longitude  | Ortho Height |
|----------|-------------|-----------|---------------|-----------------|------------|--------------|
| 736      | 93V-488     | 197725.61 | 47 31 54.72   | 122 21 18.15    | 1264520.13 | 341.20       |
| 1159     | SNV-5306    | 193777.00 | 47 31 15.5788 | -122 21 30.0522 | 1263625.00 | 379.32       |
| 1160     | SNV-5307    | 195127.00 | 47 31 28.807  | -122 21 37.6134 | 1263133.00 | 338.82       |

# Bureaucratic Challenges

**1996:**

Early network efforts were not taken seriously by key state and federal representatives

## INITIATING A NORTHWEST UNIFIED BASE STATION NETWORK



# Bureaucratic Challenges

Technological advancement disincentives

*“The less we spend, the less we will be given in the future”*



# Bureaucratic Challenges

## *Analysis Paralysis*

**Too many voices:**

- City of Seattle
- Snohomish County
- Metro - King County
- City of Renton
- Kitsap PUD
- WSDOT
- Swampish County
- Squeemish County
- Department of Procrastination
- etc
- etc
- etc
- etc
- etc
- etc
- Thurston County
- UW and CWU
- WADNR
- Island County
- Skagit County
- Pierce County
- Duwumps
- Du-Tac
- etc
- etc
- etc
- etc
- etc
- etc

# What did work!

Building the core network first, cooperative details later

Highlight cost/benefit with hard numbers from well defined pilot

Gather just enough hard data to justify establishment of the core network

Limit inclusion of “intangibles” in the business case

Avoidance of “matrix management”, limit the players

Have some fun...



**prsn.org**

# Height Modernization Funding



## The Spatial Reference Center of Washington

David Steele, PLS  
DNR Survey Manager  
Spatial Reference Council Vice Chair



WASHINGTON STATE DEPARTMENT OF  
**Natural Resources**



# Organize Statewide Resources

- ◆ Form an organization or committee
- ◆ Develop Interlocal agreements between government agencies
- ◆ Form a nonprofit organization
- ◆ Find a sponsoring agency to coordinate and manage the grant
- ◆ Form a cooperative with participation from government and private industry



# Develop a Height Modernization Plan

- ◆ Write an Implementation Plan
- ◆ Decide how to fund implementation and future maintenance of the new GPS utility
- ◆ Decide how to manage the funds when they are received
- ◆ Develop some guiding principles or bylaws, including membership structure and oversight



# Funding Height Modernization

- ◆ Build statewide political support
- ◆ Coordinate with agencies and various industries
- ◆ Work with the national geodetic survey height modernization staff and NGS advisor
- ◆ Ensure support from key appropriations congressional representatives and senators




# Funding Height Modernization

- ◆ Coordinate with the federal budget cycle
- ◆ Anticipate any challenges to sponsorship
- ◆ Resolve local funding or implementation battles and don't make them political
- ◆ NGS will not make funding decisions and will expect some political direction



# Startup Time Line

- ◆ Oct – Dec 2004
  - Build political support
- ◆ Feb – April 2005
  - Fed budget prepared
- ◆ May – July 2005
  - Push political support
- ◆ Oct 2005
  - New fed fiscal year
- ◆ Jan 2006
  - Fed budget approved
- ◆ March 2006
  - Submit grant
- ◆ May 2006
  - NOAA grant deadline
- ◆ Aug 2006
  - Receive first funds



SRCW Contact:

**W. Spencer Reeder, Director**

*Email: [sreeder@src-wa.org](mailto:sreeder@src-wa.org)*

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1111 Washington Street SE  
P.O. Box 47030  
Olympia, WA 98504-7030**

